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WHAT IS GERM PLASM?[1]

By Professor GEORGE T. HARGITT

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THE term germ plasm has become a common term. It is used by laymen as well as biologists with such diverse connotations that one can never be sure just what is meant. Weismann[2] developed a definite and specific meaning for germ plasm. As a result of his study of acquired characters and from his attempt to find an explanation of development and heredity which would be more satisfactory than the physiological units of Spencer or the gemmules of Darwin, he worked out an elaborate and logical hypothesis. Whether acceptable or not, his hypothesis merits high praise as an outstanding biological contribution which has stimulated observation, experiment and enormous discussion.

Weismann's germ plasm theory may be briefly outlined in the following points: Hereditary characters are produced by specific particles or substances called determinants, located in the chromosomes of the nucleus. Each independently variable character of an organism is due to a single kind of determinant, whether in a single cell or a group of similar cells. The germ cells alone contain all the determinants of a species needed at any and all periods of the life history of an organism, including complete or partial determinants of ancestors.

At the first cleavage of the egg two cells are produced, one of which is the primordial germ cell which takes no part in ontogeny, but remains unchanged to produce the germ cells of the individual at the appropriate time. This primordial germ cell is therefore a sample of the fertilized egg and its products will be exactly like it. The other cleavage cell is the starting point for the rest of the complex organism. During continued divisions the determinants are gradually

[1] Address of the vice-president and chairman of the Section on Zoology of the American Association for the Advancement of Science, Cleveland, September 13, 1944.

[2] A. Weismann, "The Germ Plasm." Translated. New York, 1893.

sorted and distributed to different cells as a result of qualitative nuclear divisions, until each histologically differentiated cell or group of cells in the organism has only a single kind of determinant. The determinants do not have any effect while within the nucleus, they must pass into the cytoplasm and form biophors and in this condition are active in producing specific characters.

De Vries's "Intracellular Pangenesis"[3] had been published in 1889 and Weismann was familiar with it; he accepted some of the views presented but rejected the theory. He thought de Vries had failed to consider the arrangement of the hereditary particles which Weismann designated as the "architecture of the germ plasm." According to de Vries each hereditary character is represented by a particle, the pangen, located in the chromosomes of the nucleus. Each nucleus of an organism is alike in containing every kind of pangen, all of which, at each nuclear division, are divided and passed equally into each daughter nucleus. Within the nucleus pangens are inactive, except for their ability to divide; they may pass into the cytoplasm where they grow, multiply and become active permanently or for a time or when stimulated, and produce their specific characteristics. Not all pangens of any one cell pass into the cytoplasm and become active, and the structure and behavior of a cell depends on what pangens and how many are present in the cytoplasm.

The germ plasm, according to Weismann, is the complete complex or assortment of all the determinants of the organism or species. This is found only in the nuclei of germ cells, for the nuclei of all other cells are unlike, containing only the particular determinant which is their characteristic. The gradual distribution of the determinants through qualitative nuclear divisions during ontogeny results in cell differentiation. Since only germ cells contain all the determinants it is only such cells which can produce a new organism; tissue cells can produce only their own type.

De Vries believes the nuclei of all cells in the body are alike in containing a complete assortment of all the species pangens, each of which divides and passes into the two daughter nuclei at each division, thus maintaining the completeness of the nuclear pangen complex. But pangens may divide within the nucleus at other times than at division and some of these migrate into the cytoplasm. Hence the differentiation of the cytoplasm is determined by the kind and number of pangens in it. While de Vries did not use the term germ plasm, it would be present in every cell of the body, according to Weismann's definition. Indeed de Vries says that in plants potential germinal tissue is often everywhere, producing both somatic and sex organs, and in some plants almost any cell might produce a new organism, even from highly specialized epidermal cells, as in Bryophyllum.

The opinion held at present is that the hereditary materials, or genes, are located in the chromosomes of the nucleus and every cell is alike in possessing a complete chromosome and gene complex. At each division each chromosome and gene is exactly divided and the daughter nuclei are identical. Our modern studies have been so concentrated on the nucleus and the genes that we have no definite theory of how differentiation and cytoplasmic determination is produced. Nor can one find any clear statement of how the nuclear and cytoplasmic constituents interact.

The de Vriesian, Weismannian and modern opinions agree in postulating the presence of material particles, substances or hereditary materials in the chromosomes of the nucleus which determine the characters of organisms and their parts. It is precisely this complete hereditary material of the species which Weismann called the germ plasm. In his theory it was present in only a few cells (germ cells), all others containing a part of this material; and eventually each histologically differentiated cell or group possessed a single kind of determinant or gene. His scheme involved the sorting out and distribution of genes by qualitative nuclear divisions; presumably the chromosomes would persist but all chromosomes in one cell would contain many genes of a single kind. This qualitative division was never acceptable and has long been abandoned. De Vries's theory, and our own present one, agree that both chromosomes and genes divide equally at each division. All three of these theories seem to agree that the hereditary material present in the nucleus is inactive and must pass into the cytoplasm before it can become active in producing definite characteristics.

If we retain the term germ plasm for the hereditary substance or genes we then say that all cells of the body, irrespective of the degree of differentiation or specialization, contain germ plasm. This would seem to imply that any cell potentially may produce a new organism. While botanists usually have not used the term germ plasm this implication has been more or less acceptable to them; on the other hand, zoologists generally do not believe that differentiated cells can produce a new organism. To Weismann the difference between germ cells and tissue cells was due to differences of their nuclei. Since we hold that nuclei are identical in all cells of an organism, what determines the structure, behavior and fate of cells in the organism? Genes are active, and perhaps determinative, not only in heredity but in ontogeny, but there

[3] Hugo de Vries, "Intercellular Pangenesis." Translated. Chicago: Open Court Publishing Company, 1910.

appears to be no differential element in the nucleus, and any distinction between cells would seem to be due to cytoplasmic differences. What a strange reversal: from the view that germ cells differ from tissue cells because of diverse nuclear composition to the view that all nuclei contain complete hereditary material of the species, and the differences between cells are due to the kind of cytoplasm in which the nuclei are located!

At the time it was proposed the germ plasm theory was a significant one, compatible with the facts then known. The stimulus given by it to new discussions and investigations has enormously increased our knowledge and opened many fields not then considered. The significant point at that time was the assumed distinction between germ cells and tissue cells and the relation of this to the production of new organisms. Since then the question has so broadened that it is more one of the determination of the regions of the developing organism, the factors concerned in the differentiation and organization of organs, and the capacities or potencies of cells. Is a cell determined once for all and irreversibly, or may it change? If change may occur what are the factors or conditions leading to the change and how great a modification may take place?

All cells of an organism come from the fertilized egg and theoretically it should be possible to trace the lineage of any cell from the egg. However, in practice, it is impossible to trace the lineage of one cell in any organism with a large number of cells. Weismann's theory implies that the first cleavage should produce one primordial germ cell and one primordial body cell, whose products thereafter are separate and distinct. This has never been observed. Probably the nearest approach to such an early separation of a germ cell is in the fly Miastor in which at the 8-nuclear stage a single cell is cut off. Hegner[4] traced this single cell into the 64 ova of the animal; all other nuclei and cells produced the body. Somewhat similar lineages have been traced, but never so definitely, in some flies, beetles, crustacea and few other animals. In Ascaris at the 32-cell stage Boveri[5] believed one cell with undiminished chromatin was the primordial germ cell. In the majority of animals no such germ tracks have been established, and only after most organ systems have been laid down have germ cells been identified. As a rule no specific or characteristic differences can be found to distinguish one cell from another in cleavage and early ontogeny. In vertebrates it is only by the large size of cells located in or near the developing gonad that we can distinguish germ cells.

[4] R. W. Hegner, "The Germ Cell Cycle of Animals." New York: Macmillan, 1914.

[5] T. Boveri, *Sitz. Gesell. Morph. Phys.* München. 8: 1892.

In many mammals the earliest identified germ cells begin growth early and reach their maturity before the animals are sexually mature. A period of profound degeneration of many of the early germ cells is a common thing and new, enlarged cells appear in the germinal epithelium of the ovary. Edgar Allen[6, 7, 8] and co-workers concluded that the germinal epithelium of mammalian ovaries is active throughout the mature life, producing new ova at each oestrus, some of which mature but most degenerate and die.

In most animals removal of gonads is not followed by regeneration and very commonly x-ray treatment of gonads results in ultimate death of the germ cells, which usually are not replaced from other cells. Transplantation of embryonic gonad regions into the chick allantois or mammal kidney have given varying results, the most common being that if the transplant be made before germ cells can be identified, no germ cells will be present in the transplant. However, Everett[9] recently found that if the germinal epithelium of mouse ovaries was not destroyed when transplanted in a kidney, new ova would develop from the epithelial cells.

In mammals, then, there is not shown any great capacity for germ cells to arise from other cells, except from the germinal epithelium of ovaries. But neither the observational nor the experimental studies are quite sufficient as yet to warrant a final decision on this point.

Another source of evidence on the potencies of cells is supplied from regeneration. It may be recalled that Weismann explained regeneration as due to the presence of cells with partial germ plasm situated at strategic places in the organism. In flatworms and some other invertebrates regeneration has often been ascribed to the presence of "formative" or pleuripotential cells scattered through the parenchyma; and by some, annelid regeneration is referred to similar "neoblasts." But others believe a dedifferentiation occurs and all needed replacements are derived from the mass of dedifferentiated tissue. Wilson and Penny[10] macerated sponges by squeezing through fine bolting cloth. By this method the morphological arrangement was completely destroyed; certain types of cells were held in the net and others passed through as scattered and isolated cells. Out of this mass developed a new sponge. This involved two factors: the complete reformation and integration of the morphological pattern; and the production of the missing types of cells from the isolated cells of the mass.

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Butler and Puckett[11] amputated a leg of a salamander and after the wound surface had healed observed the production of a blastema derived by dedifferentiation of local tissues. From this, and not from adjacent differentiated cells, all the tissues of the regenerate were produced. Hertwig[12] had earlier shown that the newly developed regenerate came from the wound surface and not from the whole leg. This was demonstrated by transplanting a haploid arm on a diploid body; after healing, the leg was amputated through the haploid arm close to the diploid stump and the regenerate contained only haploid cells. Umanski[13] grafted the skin of a non-x-rayed limb on an x-rayed limb, allowed this to heal, and amputated through the graft region. The tissues of an irradiated limb are incapable of regeneration, yet a normal limb regenerated, showing that the non-irradiated skin had been able to supply everything needed for the regeneration of skin, muscle, cartilage and other tissues.

In such results it is clearly shown that specialized and functional tissues and parts may possess latent capacities to change their structure and behavior in various directions. While we do not know much about the limits of this, nor precisely what factors are involved in the dedifferentiation and modified parts produced, it seems to be clear enough that cell potency is not fixed. Needham[14] says that regeneration "is a repetition of ontogenesis so far as the organ districts involved are the same, but the processes involved are of necessity somewhat different . . . but within the limits of the organ district in question the material is certainly undetermined."

Recalling that we consider the gene complex of the nuclei of all cells of any one species as identical, the question arises in how far the cytoplasm is responsible for, or determines, the character of cells, organs or regions. Long ago Conklin discussed the question of different sorts of cytoplasm in the egg, the segregation of these in different blastomeres during early cleavage, and their significance as possible organ-forming substances. This seems to have been generally accepted by embryologists and much of recent experimental embryology is concerned with the matter of organ determination and cytoplasmic differentiation. But of necessity there is also involved interaction between cytoplasm and nucleus. Harrison[15] says the egg is composed of protoplasm characteristic of the species "and different from that of any other species." Differentiation which takes place in the cytoplasm "is accompanied and controlled by the genic complex in the chromosomes. Since the latter is presumably the same for all cells of the organism, differences between cells must arise through interaction between the constant genom and the locally variable cytoplasm, in which they ultimately become visible."

Our ideas of what is involved in development and differentiation have undergone great changes as a result of experimental and biochemical investigations by embryologists and geneticists. Needham's[14] "Biochemistry and Morphogenesis" is a stimulating survey and analysis of this field. He says that determination occurs and may explain structure and behavior through the action of biochemical agents called organizers, inductors, evocators, inhibitors and the like. What a part becomes may be due to the inducing substance itself or to the ability of the part to react to the inductor. Behavior may vary under different conditions; several substances, related chemically, may be able to accomplish the same result or the same inductor will act on quite unlike regions, the result depending on the character of the reacting region. The determination may be permanent or temporary, may involve the whole system or only a small region, it may be revocable if and when new inductors become active. "It is thus clear that at some stage or other, which may be different for each tissue, all the tissues and organs will take on inductive power, *i.e.*, the inducing substance in them will be liberated from its inactive precursor." "The process of liberation of the active substance must be connected with the process of determination and histological differentiation." If the genes fundamentally determine what is to appear, the organizers and inductors must be related to them and Needham believes that, "Organizers must indeed be regarded to a large extent as the intermediary mechanisms between the gene equipment and the final form and properties of the developing animal." ". . . genes act in development by producing, inhibiting the production of, or masking and unmasking hormones, catalysts or inhibitors in more or less diffusible states."

These quotations indicate that the experimental embryologist is getting a new picture of some of the factors concerned in development and differentiation. The processes are complex, the details are vague and the causal relations can not always be specified. Embryological changes seem to be due to definite chemical substances which in turn are somehow related to interaction of nucleus and cytoplasm. To the embryologist determination has meant a definite morphological fixation of structure; to the biochemical embryologist it seems to mean a series of biochemical reac-

[11] E. G. Butler and W. O. Puckett, *Jour. Exp. Zool.*, 84: 223–239, 1940.

[12] G. Hertwig, *Arch. f. Ent.-mech. d. Organ.*, 111: 292–316, 1927.

[13] E. Umanski, *Bull. Biol. Med. Exp., U.S.S.R.*, 6: 141–, 1938.

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[15] R. G. Harrison, "Cellular Differentiation and Internal Environment." In: "The Cell and Protoplasm," 77–97. Publ. 14, A.A.A.S., 1940.

tions resulting in the production of a definite molecular pattern in the cytoplasm. One thing in this recent type of experimental work which is of great interest is the discovery of the plasticity which is sometimes found, and the ability of a part to change while the whole organism is maintained as a unit.

Sonneborn[16] described an interesting cytoplasmic-genic relationship in Paramecium aurelia. Both a gene and a cytoplasmic substance are necessary if a particular hereditary character is to appear. "When some of the cytoplasmic substance is present, the gene controls its continued production; but when the cytoplasmic substance is absent the gene can not initiate its production." If the organism has the gene but not the cytoplasmic substance the character does not appear, but when the cytoplasmic substance is added the character does develop, and since the gene then controls this substance the character is maintained in succeeding generations. Sonneborn thinks this sort of relationship may be significant in development and determination generally. He says: "All that is required to account for the production of different characters in different cells with the same genes is to have differential segregation of these cytoplasmic determiners at cell division . . ." This suggestion seems to imply a cytoplasmic origin of the particular substance independent of any genic or nuclear cooperation.

De Vries's theory provided for a nuclear-cytoplasmic interchange since his pangens could leave the nucleus and enter the cytoplasm where they became active. Several or many pangens could enter the cytoplasm and multiply there; some of these might be correlated in action or opposed, but the structure and behavior of the cytoplasm was the resultant of the influence of all the pangens present in it. Thus far our modern theory has not provided us with any clear idea of how the genes in the nucleus can influence the properties of the cytoplasm and thus determine its character. Probably we could assume that chemical substances might be made in, or be contained in, the gene and these could diffuse out of the nucleus much like de Vries's pangens. Caspersson and Schultz[17] demonstrated the presence of nucleic acids in both nucleus and cytoplasm. Mirsky and Hollister[18] give us a hint of possible means of interaction of nucleus and cytoplasm. Chromatin is "largely, if not entirely, composed of a unique substance, nucleohistone," and the chromosomal properties are really the properties of this chemical substance. Interactions might function in this way: "From the massive, indiffusible particles of nucleohistone small quantities of histone (a protein of relatively small size) are apparently constantly dissociating. If this process occurs in the living cell, and we have good reasons to believe it may, it could play an important part in the mechanisms of gene action, for it would mean that a protein component of the chromatin is diffusing out to other parts of the cell."

With our increasing knowledge of the chemistry and physics of protein, and of the biochemical aspects of biological processes new light is being thrown on old facts. But it is also compelling us to change our point of view and to speak in more specific terms than we often use. Words like germ plasm, cells, cytoplasm, chromosomes, genes suggest morphological entities, units or behavior, and may keep us from understanding or appreciating the underlying molecular phenomena which are fundamental and significant. Biological phenomena are not just chemical and physical. The question of arrangement and organization is involved but molecular patterns and groupings may be back of biological organization. Sponsler and Bath[19] point out that a considerable amount of orderliness occurs in proteins, the amino acid residues occupying definite positions in the chains of protein molecules. Since definite patterns can thus be demonstrated chemically it is possible that this may be the basis for what we think of as protoplasmic organization. We must somehow correlate the molecular and morphological aspects if we are to have the opportunity to test the behavior and significance of definite chemical substances in protoplasm.

Chromatin (and genes) are nucleoproteins which reproduce themselves. Stanley[20] states that all viruses are, or contain, nucleoproteins and "all viruses have in common the ability to reproduce or multiply when placed within living cells." Whether viruses are living or not they are close to the borderline between living and non-living proteins. Claude[21] says, ". . . it is noteworthy that, so far, organic structures found to exhibit the property of self-duplication have been shown to contain nucleic acid of the one type or the other." Might it be permissible to speculate further that substances containing nucleic acids or nucleoproteins are capable of reproducing themselves? If certain types of proteins are capable of self-repro-

[16] T. M. Sonneborn, *Proc. Nat. Acad. Sci.*, 29: 329–343, 1943.

[17] T. Caspersson and J. Schultz, *Proc. Nat. Acad. Sci.*, 26: 507–515, 1940.

[18] A. R. Mirsky and A. W. Hollister, *Trans. N. Y. Acad. Sci.*, II, 5: 190–198, 1943.

[19] O. L. Sponsler and Jean D. Bath, "Molecular Structure in Protoplasm." In: "The Structure of Protoplasm," 41–80. W. Seifriz, editor, Iowa State College Press, 1942.

[20] W. M. Stanley, "The Structure of Viruses." In: "The Cell and Protoplasm," 120–135. Publ. 14, A.A.A.S., 1940.

[21] Albert Claude, "Distribution of Nucleic Acids in the Cell and the Morphological Constitution of Cytoplasm." In: "Biological Symposia," X, 111–130. J. Cattell Press, 1943.

duction we may have the basis for the duplication and perpetuation of molecular patterns.

It may not be acceptable much longer to claim that reproduction is a unique biological property as contrasted with non-biological substances believed to be devoid of this property.

POST-WAR GEOLOGY

By Professor BRADFORD WILLARD

LEHIGH UNIVERSITY

IMMEDIATE PROSPECT

REDUCED civilian teaching schedules and smaller classes, even though partially supplemented by the introduction of ASTP, FAL, lately, ASTRP instruction, leave me time to ponder the status of post-war geology. Shall earth sciences flourish or languish, shall we have an influx of students for whom employment awaits only graduation, will the "G.I. Bill of Rights" return many of our students now in uniform? Personally, I think we shall have plenty of students. I believe curricula in geology and allied sciences will see, if not a boom, a considerable increase over pre-war registration. If so, must course content be revised? Will specialization be stressed? I believe changes must be made, particularly at graduate level because specialization will assuredly be stressed far more than in the past. Initial employment and subsequent advance in geology will go more and more to the man with the Ph.D. There may be so great an immediate demand that anybody who has rubbed elbows with geology in college can find employment, but I am looking beyond such a period to more settled conditions, steady employment. If this be so, what field or fields will have the accent; which may remain unaccented, what may drop from the picture? Where will curricular emphasis fall? What must we plan for undergraduate preparation and post-graduate specialization?

With such questions in mind, I commenced fact-gathering through correspondence and conferences with teachers of geology, geologists with the state and federal surveys, at museums, private consulting and industrial positions. In each case I tried to find out the individual's opinion on post-war geology and proper preparation of men for the work to be. Since some of the answers are confidential, I refrain from specific citations but shall summarize opinions and even have the temerity to introduce suggestions of my own.

EMPHASIS, WHERE?

Among those interrogated, optimism dominates. Geologists are generally hopeful that the science has an immediate, luminous if not scintillating future. Agreement is less general as to where greatest development will come. Nevertheless, two developments of earth science were most often mentioned: applied geology in engineering and economic geology, including mineral fuels.

Closer bonds between applied geology and certain types of engineering, particularly civil and mining, appeal to reason. How often has the civil engineer been accused of too little familiarity with the earth into which he digs, upon whose surface his structures rise? Conversely, many a geologist, called in on a construction job, has been baffled by ignorance of engineering terminology and practise. Though a man trained in neither field need master fully the other, he can have a basic knowledge thereof. A civil engineer or geologist with extra study can acquire enough knowledge to function intelligently in the complementary science. The super-highway, railroads, dams, water supply, flood control, foundations, harbor and shore installations are among civil engineering projects where geology must serve. To prepare for work on such projects, can we not, at the expense of one or two extra study years, create a civil-engineering geologist? I have had students who "split majors" in these fields even though their years in college were crowded to meet the added load. Their professional success fully justifies the preparation. While such a hybrid-trained student might split his major as suggested, he could achieve the objective if he took his bachelor's degree in geology, followed with a degree in civil engineering or *vice versa*.

There was a time a generation ago when mining engineers had a tolerable geologic training. To-day, the trend seems to be to prepare a man to lay track and string wires underground, to get out coal or ore regardless of its geologic nature and occurrence. I have no argument with this type of training, if it follows the trends of the time and fills a need of our civilization. Yet, if the old concept of the mining engineer is to be discarded, why not develop in his stead the newer concept of a mining geologist? If his education followed a program of the pattern suggested for the civil-engineering geologist, it would turn out a man capable of giving correct geologic interpretations to mining problems.

One could propose more applications of geology to engineering and allied fields. I have often felt that the metallurgist to-day is going the way of the mining

engineer, but in his case the drift is less serious since his actual contact with the raw materials is more remote. Pedology and all that it may imply in its especial dealings with the regolith embracing water supply, agricultural engineering practices, flood and erosion control, soil mechanics and allied problems are topics that must receive more geologic support.

Economic geology has been more or less arbitrarily trisected into metallic, non-metallic, mineral fuels. I believe that for economic geology, methods of study and their application rather than subject-matter will change. The war has emphasized two phases of economic geology, the strategic mineral and the depletion of mineral resources. There has been intensive search for strategic minerals or their substitutes, for low-grade deposits, for new reserves hitherto neglected, undervalued or unknown. If such exploration and exploitation are to continue, and surely they must as we more and more approach a mineral-poor civilization, old, supposedly exhausted workings may enjoy a face-lifting. We shall require new and special emphasis upon structural geology, stratigraphy, refined petrographic methods, applied paleontology (particularly micropaleontology), geochemistry and, perhaps above all, geophysical methods of prospecting. Incidentally, let it not be overlooked that, after all, civilized man's most important mineral asset is an abundant supply of fresh water. Water supply problems grow directly with population and the demand for bath tubs, even though such be ethical rather than physiologic.

Granting that engineering geology and economic geology are those fields with the most engaging future, they are not the whole picture. The emphasis which war has placed upon meteorology and climatology is alone enough to assure their future as their application to civilian needs develops. Some will say, "Oh, but meteorology and climatology are not geology!" Who said they were? They *are* earth science and they *are* consanguineous to orthodox geology. A geologist, *sensu stricto,* needs some meteorology; the converse is equally patent. So, too, with geophysics. I mentioned its application to economic geology; its bearing on engineering problems is axiomatic. Oceanography, structural and dynamical geology, seismology are likewise closely associated with earth-physics. As with meteorology, so with geophysics, the specialists in these fields and the geologist need to know something of each other's work. Their interfusion defies sharp separation.

Is the cultural side of geology defunct? Is pure science now really to become nonsense? I doubt it. I doubt if we have so far degenerated that only "practical" science can be tolerated, only the strictly utilitarian, *i.e.,* money-making, courses are worthwhile. Who expects us to give up most of astronomy or archeology, much of that part of biology we used to call "natural history"? Perhaps the days of the great fossil-hunts are gone, but speculation on organic evolution, the excavation of its fossilized, documentary evidence, description of new species, paleogeography, earth history, the very age of the earth itself are topics which surely will receive a fair share of attention among thinking men and women to be. Support of such work will continue just as long as philanthropy and curiosity retain residence in the human race. The immediate, post-war scramble for recovery and return to the ways of peace, the replacement of losses of material needs and comforts may for a few years shunt pure science on a siding, but eventually I look for its return to a clear right-of-way. From pure science have come so many great discoveries of applied science—geology is no exception.

CURRICULA

If the post-war geologist is to be a greater specialist than his *ante bellum* predecessor, thorough scrutiny of the curriculum by which he is educated professionally is imperative. Inevitable specialization in graduate studies means more years in college and university. The basis of this work is the undergraduate period. Suppose you were asked to set up an undergraduate course for the would-be geologist, what might be your reaction? Would you not take as your first or major premise that, because of specialization, our new crop of geologists must do post-graduate work? Second, whatever the post-graduate specialty, the undergraduate training must be basic and can vary little. Assuming that your geology major is committed to graduate work and that he has been "caught" early enough in his undergraduate career for fairly thorough preparation, what subjects shall he study?

It sounds paradoxical, if not downright suicidal, if I say that the fewer courses in geology an undergraduate geology major takes the better. Truly, that is overemphasis. Suppose we insist upon four basic semesters as a minimum coverage, these to be distributed among general geology, historical geology, mineralogy, including crystallography and blowpipe analysis, petrology. To these could be added a semester course each in paleontology, structural geology, field methods, map reading including photogrammetry. Beyond these I am convinced no undergraduate must travel, always provided he is destined to become a graduate student. I do not say that he shall take no more; I cite the *must* and *near-must* subjects only. If this is all the geology he is to take, what is our undergraduate to do with his time? This: distribute it broadly among as many fields as he can from the

sum total of those that are useful or essential to the geologist.

Give the undergraduate language, above all four years of English. Let him know and appreciate good literature and learn to write the language clearly, directly and yet *interestingly*. There is too much scientific writing that like some minerals is clear but colorless. Let him have a working knowledge of two modern languages, French and German. There is little advantage for him to spend years reading foreign classics. His working knowledge must be a thorough basis of grammar. This acquired, give the student a German or French geologic text, dictionary and plenty of room to flounder till he acquires a vocabulary. I disagree with those who cry out for Spanish. A speaking knowledge of that language is no doubt an asset to any who may go to South or Central America, but there is so relatively little in the literature in Spanish that its neglect will not prove fatal. Whatever the future status of European culture and languages may be, the vast geologic bibliographies printed of French and in German articles warrant the study of these languages first and always.

In engineering fields a geologist needs several courses. He must have mechanical drawing and plane surveying. With these I would somehow try to squeeze in descriptive geometry for its value in training a man to think in three dimensions. To these courses may be added one each in general metallurgy and the principles and practice of mining.

Courses in most of the major, non-geologic sciences are necessary parts of a geologist's training. He must have mathematics at least through plane trigonometry. That will take care of anything, including his surveying, he may encounter during undergraduate days, if not throughout his professional career. If he should become an engineering geologist or a geophysicist or a meteorologist, he must have more mathematics. Keep this in mind as his interests and learning progress. A year of chemistry, that is through qualitative analysis, is none too much. I should prefer to add a semester of quantitative analysis, but am not adamant on this point. Your economic geologist will need it, but he might take it in graduate school where physical chemistry may also be inserted. A year of physics is unavoidable. Should our man lean toward geophysics or meteorology, a minor in physics is advised. General biology he must have, for who dare speak in terms of bare fosil bones and empty shells but know nothing of their flesh and blood descendants? The amount of course dosage must be more or less controlled by individual interests and intentions. For a would-be paleontologist, general biology must be followed by courses in botany, ecology and perhaps embryology and comparative anatomy, especially if comparative anatomy of invertebrates is available.

I realize that I have set up an ideal, an educational vehicle with stellar attachments. That a set-up such as outlined may seldom be attained is true. Few students decide upon their major soon enough in their careers to complete such a major. They must postpone a varying percentage of the courses to graduate years. Too few curricula are liberal enough or flexible enough to permit insertion of all my suggestions. Nevertheless, here is the mark at which I aim.

Summation

Believing as I do that geology in the immediate future will have a greater application, that with that application we shall see its expansion, I present the suggestions in this paper. They are based upon careful consideration, analyses, deductions from assembled views and opinions. Specialization will mean more and better geologists but also a greater graduate school population which must be fed from the undergraduate curriculum. There, and there particularly, is the basement complex on which to build. The greatest immediate need in geology is a broad, adequate undergraduate preparation, not so much in geology itself, but in a slightly appalling list of collateral "must" subjects. Once this foundation is attained, graduate work in its several fields will care for itself.

OBITUARY

RECENT DEATHS

Professor James Alexander Shohat, of the department of mathematics of the University of Pennsylvania, died on October 8 in his fifty-eighth year.

Howard Chapin Ives, consulting civil and construction engineer, retired, formerly professor of railway engineering at the Worcester Polytechnic Institute, died on October 6, aged sixty-six years.

Dr. Earl C. Sherrard, since 1917 chemist with the U. S. Forest Products Laboratory at Madison, Wis., died on October 5 at the age of fifty-eight years.

Dr. Edward William Berger, who retired in 1943 as entomologist of the Florida State Plant Board, died on August 23. He was seventy-four years old.

Dr. William H. Schacht, mining engineer, since

1935 a member of the Board of Control of the Michigan College of Mining and Technology, died on September 29. A correspondent writes: "Mr. Schacht was president and general manager of the Copper Range Company and president of the Copper District Power Company. He was a graduate of the Michigan College of Mines, which in 1940 conferred upon him the honorary degree of doctor of engineering."

SCIENTIFIC EVENTS

THE SCOTTISH SEAWEED RESEARCH ASSOCIATION

A SCOTTISH Seaweed Research Association has been established with the cooperation of the British Ministry of Supply and the Scottish Council of Industry. It will derive half its funds from private subscription and half from the Development Commissioners.

It is reported in *The Times*, London, that through its survey and ecology division the association will attempt to discover or develop reliable methods of survey of littoral and sublittoral seaweed, and conduct surveys. The engineering division will maintain and develop *The Prospecto*, a ship specially equipped for the survey and collection of deep seaweeds. It will also be the task of this division to develop equipment for littoral surveys, for landing weed, for assisting crofters and farmers in collecting seaweed and to investigate the possibilities of pressing, drying and milling equipment. The chemistry division will study seasonal variations of various Scottish seaweeds and provide information for those engaged in the extraction of chemicals and who market or use seaweed for feeding stuffs or fertilizers.

A director will be appointed to coordinate all these activities. The board of the association is being assisted by leading scientific men and has been promised the fullest use of the facilities of other scientific organizations. It is intended that the results of the investigations will stand the scrutiny of both technical and commercial groups. The work of the association will largely determine the future development of seaweed resources in Scotland and subsidiary and allied industries associated with seaweed products.

The chairman of the association is Sir A. Steven Bilsland.

THE ALABAMA ACADEMY OF SCIENCE

THE Alabama Academy of Science held its twenty-first annual meeting in Birmingham on April 14 under the presidency of E. V. Jones, of Birmingham-Southern College. The meeting was well attended, having a registration of over a hundred members and visitors. Fifty-nine papers were presented in the various sections.

Dr. Jones's presidential address was entitled "Challenges Facing the Alabama Academy of Science."

New and reelected officers for 1944–45 are:

President, James T. MacKenzie, American Cast Iron Pipe Company, Birmingham.

President-Elect, J. M. Robinson, Alabama Polytechnic Institute, Auburn.

Vice-presidents and Section Chairmen: Biology and Medical Sciences, J. P. Reynolds, Birmingham-Southern College, *Secretary*, Alvin V. Beatty, University; Chemistry, G. H. Evans, Huntingdon College, Montgomery, *Secretary*, Davis H. Thomson, Birmingham; Geology and Anthropology, E. C. Horton, U. S. Weather Bureau, Birmingham, *Secretary*, Peter A. Brannon, Department of Archives and History, Montgomery; Geography and Conservation, J. M. Stauffer, Department of Conservation, Montgomery, *Secretary*, Thomas A. Ford, Department of Conservation, Montgomery; Physics and Mathematics, A. T. Wager, Birmingham-Southern College; Industry and Economics, W. M. Mobley, Alabama By-Products Corporation, Tarrant; The Teaching of Science, Mrs. W. D. Thompson, Birmingham-Southern College.

Treasurer, John Xan, Howard College, Birmingham, reelected for three years.

Councilor of the American Association for the Advancement of Science, Septima C. Smith, University, reelected.

Long Range Planning Committee, member, Section III, S. J. Lloyd, University.

Councilor for the Junior Academy for three years, Miss Lillian Worley, Alabama College, Montevallo.

The Alabama Junior Academy of Science was in session at the same time, at the Phillips High School, with exhibits constituting a special feature of the program.

The next annual meeting of the academy will be held in Birmingham in the spring, the date to be determined later.

WINNIE MCGLAMERY,
Secretary

DECORATIONS OF RUSSIAN SCIENTIFIC MEN BY THE SOVIET GOVERNMENT

The Information Bulletin of the Embassy of the U.S.S.R. reports the following decorations conferred on eighty-one members and workers of the Academy of Sciences of the Ukrainian SSR in recognition of notable services in various branches of science:

The highest decoration, the Order of Lenin, has been conferred upon Academician Vladimir Filatov, famous oculist, whose method of cornea transplanting has helped to restore sight to thousands of wounded men during the war. Academician Filatov has also scored important successes in the field of tissue therapy. In a number of diseases, even those entirely unconnected with the eyes,

Filatov transplants tissues into the human body, thus hastening the process of recovery.

The Order of the Red Banner of Labor was awarded to the president of the Ukrainian Academy of Sciences, Alexander Bogomolets. His well-known researches in the field of endocrinology, the physiology of blood circulation and the problem of longevity have shed light upon a number of problems of modern medicine. Academician Bogomolets has also carried on extensive studies in the problem of the connective tissues. Famous as a teacher, he heads the School of Soviet Pathologists and is author of a study on pathological physiology for which he was awarded a Stalin Prize.

The Order of the Patriotic War, First Class, was conferred upon 74-year-old Academician Evgeny Paton, for his services to the Soviet tank-building industry.

SCIENTIFIC NOTES AND NEWS

THE Distinguished Service Award of the National Council of Geography Teachers has been conferred on Dr. Gilbert Grosvenor, president of the National Geographic Society and editor of *The National Geographic Magazine,* in recognition of "his outstanding contribution to educational geography." The citation emphasizes his "forty-five years of skilful leadership in the field of educational geography as editor of the magazine and twenty-five years as president of the society. Under Dr. Grosvenor the membership of the society, which has sponsored more than a hundred scientific expeditions and has generously contributed geographic material to the public and private educational institutions in this country, increased from nine hundred to a million two hundred and fifty."

THE Mexican Government recently conferred on Dr. Harlow Shapley, Paine professor of practical astronomy at Harvard University, director of the Harvard College Observatory, the Order of the Aztec Eagle, third class, in recognition of "his cooperation in arranging for the installation of the telescope of the National Astrophysical Observatory at Tonanzintla."

THE President of Peru has conferred the decoration of the Heraldic Order El Sol Del Peru in the class of Knight Commander on Dr. J. C. Geiger, director of public health of the City and County of San Francisco. The citation reads: "As President of the San Francisco Chapter, Pan American Society, Dr. J. C. Geiger has aided materially in fostering and cementing friendly relations between countries of the Americas; as a teacher of preventive medicine and public health in universities, medical officer of health and chief of hospitals, he has added much to the glorious chapter of the prevention of disease." The Order of the Sun of Peru was founded in 1821 by San Martin, and is the oldest in Latin America.

ON the occasion of the opening ceremonies on October 10 of the annual display of roses at the Brooklyn Botanic Garden, a reception for members and guests was given in honor of Dr. George S. Avery, Jr., who was appointed recently director of the garden to succeed the late Dr. C. Stuart Gager.

WILLIAM GAERTNER, founder and active head of the Gaertner Scientific Corporation, known for his work in the design and production of high-grade precision instruments, will celebrate his eightieth birthday on October 24.

THE Genetics Society of America announces the election of the following officers for 1945: *President,* Dr. Barbara McClintock, of the Department of Genetics of the Carnegie Institution at Cold Spring Harbor; *Vice-president,* Dr. Paul C. Mangelsdorf, professor of botany at Harvard University.

AT the annual meeting in Cleveland on September 12 of the American Microscopical Society, the following officers were elected for the year 1945: *President,* Dr. Raymond C. Osburn, the Ohio State University; *First Vice-president,* Dr. Charles Drechsler, U. S. Department of Agriculture; *Second Vice-president,* Dr. Enrique Beltrán, University of Mexico; *Elective Member of the Executive Committee,* Dr. L. J. Thomas, University of Illinois; and *Member of the Spencer-Tolles (endowment) Committee,* Dr. Paul S. Welch, University of Michigan.

AT the annual meeting of the Paleontological Research Institution, held at its headquarters in Ithaca, New York, the following officers were elected for the ensuing year: *President,* Kenneth E. Caster, University of Cincinnati; *Vice-president,* Ralph A. Liddle, Fort Worth, Texas, and Ithaca, N. Y.; *Secretary,* Rebecca S. Harris; *Treasurer,* Gilbert D. Harris; *Assistant-Treasurer,* Katherine V. W. Palmer.

AT the meeting of the American Association of Colleges of Pharmacy, held at Cleveland in September, Dr. Henry S. Johnson, dean of the College of Pharmacy of the University of Connecticut, was named president-elect for the year 1944–45.

DR. GEORGE LYNN CROSS, professor of botany and chairman of the department of the University of Oklahoma, assistant dean of the Graduate College and acting director of the Research Institute, has been elected president of the university.

THE Commonwealth Fund has established a fund to bring visiting professors to the School of Medicine of the University of Louisville. Dr. Carl V. Moore,

associate professor of medicine of the School of Medicine of Washington University, was in residence from October 9 to 21, and Dr. William F. Windle, professor of neurology and director of the Institute of Neurology of Northwestern University, will be in residence during the month of November.

DR. G. WILSON SHAFFER, dean of the College of Arts and Sciences of the Johns Hopkins University, will be visiting professor of psychology at Goucher College during the first term of the college year.

PROFESSOR JOHN E. BURCHARD, director of the Bemis Foundation, has been appointed director of libraries at the Massachusetts Institute of Technology. He will assume administrative direction of the library and museum system of the institute, but he will have as his immediate and major task the planning of a broadened program of library service. Included in this program is the development of plans, for which the institute hopes to secure the necessary funds, for a new library building that will not only serve as a great central scientific and technical library, but also as a center of the humanities and a broad program of cultural activities.

AT the Louisiana State University, Dr. H. V. Howe, director of the School of Geology, has been made dean of the College of Arts and Sciences, and Dr. E. A. Fieger has become head of the newly established department of agricultural chemistry and biochemistry. Dr. R. L. Menville, owing to ill health, has been retired at his request as dean of the College of Chemistry and Physics. The title of dean emeritus has been conferred on him. He is succeeded by Dr. A. R. Choppin.

DR. AMEDEO S. MARRAZZI, head of the department of pharmacology and therapeutics of the School of Medicine of Loyola University, Chicago, has been appointed professor and head of the department of pharmacology of the College of Medicine of Wayne University.

DR. H. C. EYSTER has been promoted to an associate professorship of botany at the University of South Dakota, Vermillion.

DR. ALTON GOLDBLOOM has been appointed chairman of the department of pediatrics at McGill University and acting physician-in-chief to the Children's Memorial Hospital, Montreal. He succeeds Dr. R. R. Struthers, who has joined the UNRRA as pediatric consultant.

DR. FREDERICK M. FEIKER, dean of the School of Engineering and professor of engineering administration at George Washington University, has been appointed a member-at-large of the National Research Council, and has been assigned to the Division of Engineering and Industrial Research.

DR. GUSTAV A. SWANSON, associate professor of entomology and economic zoology at the University of Minnesota, has been appointed biologist in the Division of Wildlife Research, U. S. Fish and Wildlife Service. He is in charge of the cooperative wildlife research unit program and will serve also as liaison officer on the Pittman-Robertson research projects to correlate scientific data acquired through the expenditure of Federal aid funds. Dr. Swanson's headquarters will be in Chicago, Ill., at the central offices of the service.

DR. GERHARD LEHMANN, associate professor of pharmacology at the School of Medicine of the University of Louisville, has resigned to become pharmacologist for Hoffmann-La Roche, Inc., Nutley, N. J.

DR. MILTON HARRIS has resigned as director of research of the Textile Foundation and the Textile Research Institute, effective on January 1. At that time he and a number of members of the staff who have been working with him will continue their activities in a research and consulting organization to serve the textile and allied industries under the name of the Milton Harris Associates.

DR. MILTON J. FOTER has recently been appointed head of the department of bacteriological research of the Wm. S. Merrell Company.

The Harvard Alumni Bulletin reports that Stanley F. Morse, who has been in practice for twenty-five years as an agricultural consultant, is serving as chief of the American Food Mission which has been sent to French North Africa by the U. S. Foreign Economic Administration. The mission will cooperate with and assist the French Committee of National Liberation in its efforts to restore food production to its pre-war volume in Tunisia, Algeria and Morocco.

PROFESSOR GASTON RAMON, director of the Pasteur Institute in Paris, and his family are reported to be safe and in good health. Dr. Ramon is the discoverer of the diphtheria toxoid and tetanus toxoid immunization and the flocculation test of diphtheria toxin.

DR. WILLIAM DEB. MACNIDER, Kenan research professor of the School of Medicine of the University of North Carolina, delivered the commencement address at the University of Louisville School of Medicine on September 8. On August 25, Colonel R. Arnold Griswold, head of the department of surgery, who is on leave of absence with the Army, chief of the surgical service at Walter Reed General Hospital, delivered the Alpha Omega Alpha lecture.

THE four hundred and seventh meeting of the American Mathematical Society will be held at Columbia University on October 28. There will be sessions at

10:30 A.M. and 2:00 P.M. By invitation of the Program Committee, Professor Gordon Pall, of McGill University, will deliver an address entitled "The Arithmetical Invariants of Quadratic Forms."

THE Albert and Mary Lasker Foundation, Inc., has established the Lasker Award of $1,000 to be given annually through the National Committee for Mental Hygiene "for outstanding service in the field of mental hygiene." It will be conferred at the annual meeting in the autumn of each year. The purpose of the award is to recognize significant contributions for the promoting of mental health and to making the field of mental hygiene more familiar to the general public. Each year the award will be made for a contribution in the special aspect of the subject which seems to be of the most immediate and current significance. The recipient will be selected by an anonymous jury chosen annually for its competence to judge accomplishment in a particular field. The award this year will be for work in mental hygiene related to the war.

THE Ordnance Distinguished Service Award has been presented to the American Standards Association "in recognition of outstanding and meritorious engineering advisory services, in war and peace, for the development, manufacture and maintenance of ordnance materiel."

A SCIENTIFIC fungus farm—one of the first of its kind—has been established at the Works Laboratory at Schenectady of the General Electric Company so that engineers, by studying the characteristics of fungi, may prevent interference with the best performance of war equipment.

THE Michigan College of Mining and Technology has established an assistantship in engineering English, to give training in the teaching of speech, technical writing and literature to engineering undergraduates. The assistant will be aided by the engineering staffs in studying the application of language skills to engineering work. He will do a considerable amount of classroom teaching, will assist in the editing of technical papers, and will otherwise familiarize himself with the major problems of English instructors in technical colleges.

WITH a view to assisting scientific men and scientific institutions to become acquainted with the work of their Latin American colleagues, the Division of Intellectual Cooperation of the Pan American Union is publishing a tentative directory of journals dealing with the natural, physical and mathematical sciences published in Latin America.

Industrial Standardization states that the Argentine Government recently published a decree creating the Instituto Nacional de Tecnología. It is expected to have two sections, one for research and the other for technical matters, each with a managing director. Reports from Argentina indicate that the organization will be administered by a board composed of a general manager and the directors of the two sections. Industrial firms and business houses may become members, as well as other organizations that have been approved by the executive power of the nation.

A GRANT of 3,000 rupees per annum has been sanctioned by the Government of Travancore to the Indian Institute of Science, Bangalore, for three years from 1120 (1944–45), for a lectureship in the department of applied chemistry, to be called "The Maharajah of Travancore Lectureship in Applied Chemistry."

WITH Lord Nuffield's approval the trustees of the Nuffield Foundation have decided to allocate £10,000 a year for a period of ten years for a chair of child health in the University of London. The financial assistance provided by the foundation will enable a post-graduate Institute of Child Health to be established for teaching and research. It is proposed that the institute be associated with the Hospital for Sick Children, Great Ormond Street, and the Obstetric Department of the British Post-Graduate Medical School at the Hammersmith Hospital.

The British Medical Journal reports that the terms of reference of the Scottish Scientific Advisory Committee have been revised and are now as follows: "To advise the Secretary of State on the application of the results of scientific research to public health administration and to promote medical investigations designed to assist the Secretary of State in the discharge of his responsibilities for the health services in Scotland." Membership of the committee has been widened in the interests of medicine generally and includes Sir John Orr (chairman), Professor D. Cappell, Professor F. A. E. Crew, Professor E. W. H. Cruickshank, Professor D. K. Henderson, Professor J. Hendry, Sir A. S. M. Maegregor, Professor T. J. Mackie, Professor J. W. McNee, Professor C. McNeil and Professor Noah Morris. Dr. I. N. Sutherland, of the Department of Health for Scotland, is medical secretary. Normally the appointment will be for four years, but to provide for rotation five of the members now appointed will retire after two years. The chairman of the Medical Advisory Committee, Sir John Fraser, and the secretary of the Medical Research Council, Sir Edward Mellanby, are *ex-officio* members of the committee.

THE forestry program recommended to the British Government by the Forestry Commission for adoption after the war proposes that in the interests of

national security the country's forest area be increased by 5,000,000 acres. This plan provides for the afforestation of 3,000,000 acres of bare land which has little agricultural value, and for the "dedication" to forestry by the owners, or acquisition by the State, of 2,000,000 acres of existing woodlands in private ownership. The Forestry Commission now owns 1,250,000 acres of land, of which 779,000 acres are plantable and 440,000 acres are already planted. The proposed future program, which would be spread over fifty years, would mean the acquisition of about 2,000,000 acres more for afforestation.

DISCUSSION

THE UTILITY OF MAJOR FOREIGN LANGUAGES IN PHYTOPATHOLOGY

THE check lists, listing literature received by the U. S. Department of Agriculture, published successively as "Botany Current Literature," "Plant Science Literature" and "Bibliography of Agriculture," represent comparable and extensive cross-sections of the world literature in the plant sciences. To determine the trend in numbers of publications in phytopathology in each of the major foreign languages, counts were made of the foreign language papers in this field included in these check lists for the years 1931, 1935, 1942 and 1943. The results of these counts are given in Table 1.

TABLE 1

NUMBER OF PHYTOPATHOLOGICAL PAPERS LISTED IN EACH FOREIGN LANGUAGE

Year	German	French	Russian	Spanish	Portuguese
1931	210	149	67	49	6
1935	209	118	107	42	19
1942	7	2	17	69	41
1943	27	3	2	84	25

The marked decrease in German, French and Russian papers from the levels of 1931 and 1935 to those of 1942 and 1943 is evidently due mainly to total mobilization for military purposes with consequent curtailment of scientific investigation, and to a more limited extent to interference with receipt of journals in America. This decrease is all the more significant when we consider that of all the botanical sciences, phytopathology is most closely linked to war production, a fact that is seen in heightened activity in this field in both Great Britain and the United States during both world wars. These low levels of scientific production are likely to last long after the termination of the war because of a necessary lag in the restoration of a psychological, economic and political equilibrium which will permit and encourage a resumption of research, and because of a deficit of trained scientists.

In contrast, there has been a steady increase in the numbers of Spanish and Portuguese papers, indicating an increase in agricultural research in South America, inasmuch as few of the papers listed originated in either Spain or Portugal. This increase is likely to continue in the future because of the almost certain extensive development of agriculture in South America, because of the encouragement of science in South America by the United States which is evident in many forms, *e.g.*, exchange scholarships, fellowships and professorships, and outright grants to South American countries for scientific purposes, and because of the probable absence of handicaps from post-war adjustments in South America.

In the future, Spanish and Portuguese may become more useful languages to scientists than French, for several reasons: (1) an increase in the quality and number of publications from South America can be expected; (2) the effects of the psychological, economic and political disruption in France are shown by the paucity of phytopathologic contributions from that country since 1940, when hostilities ended in France, and these effects are so deep-rooted that many years may be required before the pre-war level of productiveness can be expected in France; and (3) of the four principal Romance languages used in scientific publication, Spanish, Portuguese and Italian are more closely related to one another than is French to any of the other three, so that familiarity with any one of the first three has broader usefulness than French as a key to the other Romance languages.

Prior to the outbreak of the war, the number of technical papers in Russian was accelerating, whereas publication in French and German had reached more constant levels. The high degree of organization of agricultural research in Russia and the advantages of being a victorious participant in the war, coupled with the pre-war acceleration of research and the great diversity and extent of hitherto unstudied agricultural problems in Russia, all point toward the increasing importance of scientific contributions from that country after the war in comparison with France and Germany.

The present and potential increase in numbers of Spanish and Portuguese contributions from South America and the potentialities of Russian agricultural science following the war indicate a need for the revaluation of the utility of languages in the graduate training programs of agricultural scientists. A practical application of this would involve substitution of

Spanish (Portuguese) or Russian or both for one or both of the members of the traditional German-French requirement.

J. HARVEY MCLAUGHLIN
OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

THE THREAT TO PURE SCIENCE[1]

AT a time when the allied victory for the cause of freedom is not far away, there is a growing danger to intellectual freedom throughout the civilized world. Although the activities of most of mankind are such that intellectual freedom is but an abstraction to them, nevertheless it must be remembered that freedom, like peace, is indivisible and that ultimately even the four freedoms would be endangered were intellectual freedom to go. Specifically, it is the danger to freedom in science that I write of. This danger arises from the totalization and socialization of science which is growing throughout the entire world. In Russia, it has already been achieved by the State; in England, the movement is strong—possibly due to the intellectual consciousness of the English Labor Party and Socialist societies—and in this country, paradoxically enough, it is the ever-increasing employment and importance of physicists in industry—the professionalization of physics—that will ultimately destroy freedom in science. A society founded on technology, and free from want, may be able to give comfort and satisfaction to its citizenry, but it would lack those distinguishing qualities that go to make a civilized and cultured society.

There is a good chance in the near future for some governmental control in science. Only the great industrial nations will be able to wage war in the future, since industrial advancement as well as advancement in the machines and instruments of war depend, in the main, on directed research. The profession of medicine is already well on the way toward socialization.

The socialization of medicine offers no direct danger to intellectual freedom since the great majority of practitioners, being professional men, have neither time nor inclination to engage in research. Furthermore, as professional men they have no interest in pure science. Not until a scientific discovery or advance has gotten to the stage where they can use it, does it concern them. And then they are only concerned with its use and not with the scientific principles involved. However, it is different in physics. Here the industrial or professional physicists employed by corporations do pursue research in physics. But their research is directed toward technological achievement. The basic science of physics is becoming a servant of the industrial corporation and society. Already the American Institute of Physics is seeking to define "the profession of physics" and it is this professionalization which is inviting government control. As long as physics was confined to the university there was no danger of this. The average teacher of physics at a college or a university, though not necessarily a research scientist, has felt, on the whole, a moral responsibility to uphold pure science. But I doubt whether the majority of the industrial physicists, not being in a university environment nor under the influence of the traditions of a university, feel that way. The interests of the industrial—the professional—physicists may not always be the same as those who consider the freedom and autonomy of pure science paramount.

The ever-increasing employment of physicists by the industrial corporations of this country accelerates the social impact of the physical sciences, and society begins to look around for some social control. The technological aspect of physics looms to undue importance before the public.

An eminent English economist has recently said that "the man of science should be on tap but not on top." This statement sums up the totalitarian view very nicely, as it does the position of the professional physicist in society. It looks upon the great man of science not as a creative spirit who achieves those virtues unique with man—reason, detachment and understanding—but as somebody to be used by society when the need suggests it.

Science is an intellectual activity—its very nature is not practical. It has an intrinsic goodness, for it brings us an enrichment of living and gives us a glimpse of the infinite complexity and fascination of the universe. Because the pursuit of truth and the passion for understanding give a dignity and nobility to man, its value can not be measured by any material standard. If man is not to live by bread alone, pure science must remain free, autonomous and supported for its own sake.

ALEXANDER W. STERN

[1] See address by Professor P. W. Bridgman, SCIENCE, February 12, 1943, and his article on "The British Society for Freedom in Science," in SCIENCE, July 21, 1944.

A PLEA TO RAMAN SPECTROSCOPISTS

IN abstracting Raman data for the "Annual Tables of Physical Constants" it is necessary for the abstractor to have for each compound the empirical formula, the Geneva name—if it is an organic compound—and information as to whether the spectrum was obtained with the sample in the solid, liquid, or gaseous state; or in solution in a given solvent at a given concentration.

Frequently this information is either not given in the paper or is given in such a manner that consider-

able time is required to interpret it. For example, in one 1944 paper about three hours were required to find the necessary information for only six compounds. Since hundreds of compounds are to be abstracted, this becomes a slow and tedious task.

It seems that it would be relatively easy for the authors, who are familiar with the compounds upon which they are reporting, to give the aforementioned information in their papers, preferably in connection with the table of data. If this were done, the data could be abstracted much more easily and quickly.

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ANOTHER MASTODON FOUND IN OHIO

WITHIN the last few weeks, the skeleton of a mastodon was found on the farm of Carl Work, located about 2 miles northeast of Jackson, Ohio, and approximately 12 miles from Wooster. The bones were found protruding from the bank of a drainage ditch. The skull with the two tusks, the neck vertebrae and a number of ribs were unearthed. The entire skeleton was not present and apparently the rear portion of the animal had been removed, either during the excavation of the ditch or subsequently by erosion. The tusks, which are complete, are three feet in length and 4 inches in diameter at the base. The teeth are in excellent condition. The bones indicate a small animal. The material in which the skeleton was embedded is a muck deposit. An examination of the soil at the depth of three feet, which was the horizon of the skeleton, indicates that it is a layer of peaty material covered by sandy loam. The fact that it is a flat stretch of land, which was originally so poorly drained that a drainage ditch was necessary, combined with the evidence of a peaty formation, indicates that at one time the area was a swamp. Doubtless, at some time after the great Ice Age, this animal was mired in the bog and died there. A few years ago, parts of another mastodon were found in bog deposits near Benton, Ohio, located not far from the spot where a giant sloth was unearthed. The latter, found at a depth of five feet, was embedded in marl and peat in an area known as "The Plains" south of Millersburg, Ohio.

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SCIENTIFIC BOOKS

PUBLICATIONS OF THE MATHEMATICAL TABLES PROJECT

Table of the Bessel Functions $J_0(z)$ and $J_1(z)$ for Complex Arguments. By the Mathematical Tables Project, under the sponsorship of the National Bureau of Standards. xliv + 403 pp. New York: Columbia University Press. 1943. $5.00.

Tables of Lagrangian Interpolation Coefficients. By the Mathematical Tables Project. xxxvi + 392 pp. New York: Columbia University Press. 1943. $5.00.

Table of Circular and Hyperbolic Tangents and Cotangents for Radian Arguments. By the Mathematical Tables Project. xxxviii + 410 pp. New York: Columbia University Press. 1943. $5.00.

Table of Reciprocals of the Integers from 100000 *through* 200000. By the Mathematical Tables Project. viii + 201 pp. New York: Columbia University Press. 1943. $4.00.

FOR the prosecution of the American war effort, in which mathematical research is playing such a fundamentally important role, it is difficult to imagine any more important event than the organization early in 1938 of the computing group under the direction of Dr. Lyman J. Briggs, director of the National Bureau of Standards. With Dr. Arnold N. Lowan, the able technical director of the group, many manuscripts of fundamental mathematical tables were prepared. And the nucleus of the original great group is still very active while dealing with problems of the Applied Mathematics Panel of the National Defense Research Committee.

Up to the end of 1942 the Mathematical Tables Project had published 15 bound volumes. To these are now added four volumes, the first to be published by the Columbia University Press. The first three of these are of particular importance.

The table of Bessel Functions $J_0(z)$ and $J_1(z)$, for complex argument, $z = re^{i\phi}$, has the range $r = 0(.01)10$; $\phi = 0(5°)90°$; to 10 places of decimals. For $\phi = 0°$, the table is really of $J_0(r)$, $J_1(r)$ for every hundredth of a unit of the argument. For $\phi = 45°$, we have the most extensive table of ber, bei, ber′, bei′ functions yet published. The same may be said of the tables of $I_0(r)$ and $I_1(r)$ for $\phi = 90°$, although Aldis in 1899 published a 21-place table for each tenth of a unit 0 to 6, and an 18-place table for each unit 6 to 11. Except for Dinnik's trivial and highly erroneous three-page table of 1922, this volume contains the first table of the kind. We understand that the Project has prepared similar tables of $Y_0(Z)$, $Y_1(Z)$.

The volume of tables of Lagrangean Interpolation Coefficients will be welcomed by all users of tables, and especially by those computing with machines. The main part of this volume is occupied with 9 tables

of which the first, a Three-point table, $-1(.0001)+1$, is exact. This is followed by 8 tables each, to 10 places of decimals: a Four-point table, $-1(.001)0(.0001)+1(.001)2$, and so on to an Eleven-point table, $-5(.1)+5$. The volume contains other tables of importance for dealing with special problems. Previously published were special tables of Huntington, Kelley and others, but nothing as comprehensive and useful as the present volume.

The main table of the third volume under review is devoted to the Circular and Hyperbolic Tangents and Cotangents for radian arguments ranging from 0 to 2 at intervals of 0.0001. The number of decimal places varies from 5 to 13 for the different functions and different argument ranges. The only previous comparable table for radian argument was the unreliable table of Hayashi, 1926. Hence the volume under review fills a real gap in the field of tables of such elementary functions.

The 7-figure table of Oakes for reciprocals of numbers from 1 to 100 000 has long been in use. The new volume expands by tenfold the scope of existing tables for the interval 100 000 to 200 009.

The first three volumes have valuable introductions and bibliographies.

We are happy to learn that two more volumes of the Mathematical Tables Project, bringing the total number to 21, are to be published by the Columbia University Press in the near future. These are (a) Tables of $\sin^{-1}x$; (b) Table of Associated Legendre Functions. This is a noble and remarkable array of most useful volumes to be published in a five-year period.

R. C. ARCHIBALD

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ADVANCES IN ENZYMOLOGY

Advances in Enzymology and Related Subjects of Biochemistry. Volume IV. By F. F. NORD and C. H. WERKMAN. Illustrated. viii + 332 pp. New York: Interscience Publishers, Inc. 1944. $5.50.

THE hybrid vigor of biochemistry appears clearly in Volume IV of "Advances in Enzymology." Through the resourcefulness of the biochemist more and more biological problems are being brought within range of the methods and concepts of chemistry. The biochemical systems that are gradually emerging must often surprise and bewilder the chemist as well as the biologist. The vigor of the hybrid science is perhaps more apparent in the "Advances" than it is in the various journals of biochemistry. In them it has become necessary to restrict and even standardize papers, so that much of what an author has to say never gets into his papers. We all know how a talk with a man in his laboratory clarifies and explains a field of investigation. Reading a chapter in the "Advances" is, at its best, like listening to a worker in his laboratory.

And the chapters in "Advances" are about as varied as the kinds of talk one hears in different laboratories. There are chapters that are severely factual; there are those that are heavily laden with speculation, more heavily than the assembled data can support; and there are also several chapters in which fact and theory are nicely integrated. For the present reviewer there was something of interest in every chapter. Even the chapter by Jensen and Tenenbaum on "The Influence of Hormones on Enzymatic Reactions" is enlightening to the reader. Here is a subject that must surely become one of the great fields of investigation. Even so, the authors are able at present to review it in eight and one-half pages. One can imagine the dismay of the editors when they received the manuscript of this brief chapter with its imposing title. The effect on the reader is sobering and convincing: a valuable paper.

Another short chapter is on "The Transamination Reaction" by Herbst. This chapter consists essentially of a brief, critical summary of the work by the Russian biochemist, Braunstein, along with an interesting comparison of the work by Herbst on nonenzymatic transamination. If transamination is one of the newest fields of investigation in enzymology, the study of emulsin is one of the oldest. The most active American worker in the field, Pigman, contributes a chapter on the "Specificity, Classification and Mechanism of Action of the Glycosidases." In the study of these enzymes the biochemist has been meticulous in the attention he has given to the various substrates used but rather surprisingly carefree in the attention given to the enzymes themselves. Investigation of the glycosidases would appear to have been too little influenced by the contributions to enzymology of Sumner and of Northrop and Kunitz. Another essentially factual chapter is on "The Absorption Spectra of Vitamins, Hormones and Enzymes" by Brode. This is a useful summary, and on the whole the reviewer must accept the word of a leading authority on chemical spectroscopy. There is, however, on page 277, a figure exhibiting the absorption spectra of amino acids which could be misleading. In this figure the relative positions and extinction coefficients of the curves given for tyrosine and diiodotyrosine are almost the reverse of what they would be in the region of neutrality. The reason for this is that the curve for tyrosine represents the absorption of this amino acid in 0.1N NaOH and the curve for diiodotyrosine represents its absorption in 0.1N HCl. These facts should have been given either in the legend of the figure or in the text.

If the authors of the chapters that have just been mentioned never stray far from experimental data, this must be attributed to their own individual temperaments rather than to editorial censorship, for right next to the carefully pruned "Influence of Hormones on Enzymatic Reactions" is the luxuriant growth of "Biological Energy Transformations and the Cancer Problem." The author of the latter, V. R. Potter, is not intimidated in the least by the intricacies of biological energy transformations, and he shows that he knows his way about in this field, but in order to reach the cancer problem from this well-trodden field he has to pass through a maze consisting of nucleoproteins, the Rous tumor virus and other assorted odds and ends. In this maze he is not so surefooted. It is supposed that the clue to the cancer problem lies in an understanding of the interrelationships between the tumor virus, the synthesis of nucleoproteins and the energy transformations of the cell. "The Chemical Formulation of Gene Structure and Gene Action" also has a decided speculative orientation. There is here much to arouse the interest of biochemists, who are only beginning to be aware of one of the greatest of biological problems. Much of Gulick's discussion of the chemical nature of the gene is unfortunately marred by an acceptance of certain theories of the constitution of proteins that already have been discredited.

When discussing problems of cancer and the gene it is at present exceedingly difficult to bring observation and theory into satisfactory relation to each other. In the two chapters yet to be considered the problems discussed are more amenable to satisfactory treatment. In "Gramicidin, Tyrocidine and Tyrothricin" Hotchkiss shows that, although these substances are, because of their toxicity, of quite limited value as therapeutic agents, an understanding of their chemical constitution and mode of action on living cells is of general interest. The observations concerning the effect of gramicidin on the phosphate-uptake of cells, for example, provides a novel insight into the problems of cellular metabolism. "Tyrosinase," by Nelson and Dawson, has been saved for the last simply because reading it gave the reviewer so much pleasure. Here is an intricate subject treated clearly and convincingly. There has been no lack of controversy in this field, and yet the authors succeed in giving fair treatment to the views of others, although they do not hesitate to consider the problem as a whole from their own point of view. A paper like this one on tyrosinase could be written only by authors who have worked in this field for many years and have discussed the subject with their students from every point of view. The reader of this account of their work is struck both by the fine achievement and by the promise of more to come. Two items that especially impressed the reviewer are: the evidence that one enzyme can be involved in two entirely different reactions; and the evidence that tyrosinase becomes inactivated by the process of enzymatic activity itself, rather than by any known products of the reaction it promotes.

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SPECIAL ARTICLES

NORMAL HUMAN STROMATA AS ANTIGENS FOR COMPLEMENT FIXATION IN THE SERA OF PATIENTS WITH RELAPSING VIVAX MALARIA[1, 2]

SEVERAL publications have dealt with the use, in tests for complement fixation in the sera of human patients with malaria, of antigens prepared from the blood of monkeys heavily infected with *Pl. knowlesi*[3] or from that of chickens heavily parasitized with *Pl. gallinaceum*.[4] Positive reactions were usually encountered only after several paroxysms in the first attack, persisted for some weeks or months, and occurred especially frequently after relapses. Kligler and Yoeli[4] noted, also, that sera of occasional malaria patients fixed complement with antigens prepared from normal chicken erythrocytes. It has now been found that such malarial sera as react with antigen from normal chicken stromata also fix complement more strongly with normal human stromata, and that many malarial sera which fail to react either with *gallinaceum* antigen or normal chicken stromata fix complement strongly with the normal human antigen. Although immunologically non-specific, this reaction appears reasonably disease-specific for malaria, with easily excluded exceptions such as noted below, for in tests on 32 normal and 81 pathological sera only 4 probable false positives were found among the latter.

[1] The work described in this paper was carried out under a contract recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and Columbia University. Filed with the Committee on June 1, 1944.

[2] From the Department of Medicine and Division of War Research, Columbia University, College of Physicians and Surgeons, and the Presbyterian Hospital, in the City of New York.

[3] M. D. Eaton and L. T. Coggeshall, 1939, through L. T. Coggeshall, A.A.A.S. Symposium on Human Malaria, Washington, 1941. A. D. Dulaney, W. K. Stratman-Thomas and O. S. Warr, *Jour. Infect. Dis.*, 70: 221, 1942.

[4] I. J. Kligler and M. Yoeli, *Am. Jour. Trop. Med.*, 21: 531, 1941.

These were shown by sera from a case of severe gastro-intestinal bleeding with many transfusions, and from three cases of secondary syphilis, two immediately after the 3-day arsphenamine drip treatment, the other immediately after 4 days' treatment with penicillin, 600,000 units in all. Malaria appeared rigorously excluded in two of the presumably false-positive cases and unlikely in the others. In three of these instances complement was also fixed strongly with *gallinaceum* antigen.

In the sera of patients with malaria, the reaction with normal stromata appeared less frequently in pareties with induced malaria than in chronically relapsing *vivax* cases. In the serological check-up of the latter group, then, the readily available normal human stromata appear to be about as sensitive an indicator as the more difficultly accessible and expensive *gallinaceum* antigens thus far available. The experimental basis for this conclusion is summarized below for 167 sera of 23 chronically relapsing *vivax* patients studied at weekly intervals for one to three months:

Antigen:	*Pl. gallinaceum*	Normal human stromata
No. of patients positive (++ fixation or more) at least once	16	14
Per cent. positive patients	70	61
No. of positive reactions in 167 tests	37	47
Per cent. positive reactions	22	28

Kligler and Yoeli[4] have noted that *knowlesi* and *gallinaceum* antigens are of roughly equivalent value in the complement fixation tests.

The immunologically non-specific malaria reaction with normal human stromata is not of the Forssman type, since all sera showing agglutination of sheep cells were absorbed with these before carrying out the complement-fixation tests. The reaction is apparently due to an auto-antibody, but occurs with the stromata of other species as well. A detailed discussion will be given in a later, more complete publication.

The normal human stromata antigen is prepared as follows: Washed human red cells, preferably from freshly drawn blood, are poured into several volumes of chilled water saturated with CO_2. The precipitated material is centrifuged in the cold, washed several times with cold 0.2 per cent. NaCl solution, taken up in a 2:1 mixture of cold 0.9 per cent. NaCl and 1.26 per cent. $NaHCO_3$ solutions, and frozen until the next day, when it is thawed and centrifuged. The insoluble material, which carries the major portion of the active antigen, is suspended smoothly in 0.9 per cent. NaCl solution and lyophilized in small quantities in ampoules which are then vacuum-sealed and stored in the cold. For use, each sample is rehydrated and diluted to about four blood volumes, or more if necessary in order not to exceed one quarter of the minimum anticomplementary dose. Different preparations varied in reactivity, but not in relation to the blood groups involved, some of the most active lots deriving from O cells.

MICHAEL HEIDELBERGER
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INDUCTION OF LEUKEMIA IN MICE[1]

MOUSE leukemia appears spontaneously in a high percentage of mice of particular inbred strains.[2,3,4,5] The disease can be induced in others by the administration of carcinogens,[5,6,7,8] exposure to x-rays,[9,10] or injection of estrogenic hormones.[11,12] Onset of the disease has been accelerated by the action of carcinogens in three of the four high leukemia strains tested;[5,6,7,13] similar studies have not been reported on x-rays and estrogens. A low leukemia strain susceptible to the induction of leukemia with estrogens proved to be resistant to induction of the disease with one of the carcinogenic hydrocarbons, methylcholanthrene.[14] X-rays and methylcholanthrene were independently and synergistically leukemogenic for F_1 hybrids of Furth's Rf and Ak stocks;[15] synergism was not demonstrable for strain dba mice which proved susceptible to induction of leukemia by methylcholanthrene but not with x-rays.[16]

The present investigation was undertaken to determine to what extent susceptibility of a strain of mice to one leukemogenic influence implies susceptibility of the same strain to other leukemia-inciting physical or chemical agents. Mice of four stocks (strains F, A,

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[1] This investigation has been aided by grants from The Jane Coffin Childs Memorial Fund for Medical Research and the Cancer Fund of the Graduate School of the University of Minnesota.

[2] M. N. Richter and E. C. MacDowell, *Proc. Soc. Exp. Biol. and Med.*, 26: 362, 1929.

[3] J. Furth, M. R. Seibold and R. R. Rathbone, *Am. Jour. Cancer*, 19: 521, 1933.

[4] A. Kirschbaum and L. C. Strong, *Am. Jour. Cancer*, 37: 400, 1939.

[5] J. J. Morton and G. B. Mider, SCIENCE, 87: 327, 1938.

[6] J. Furth and W. A. Barnes, *Cancer Research*, 1: 17, 1941.

[7] A. Kirschbaum, L. C. Strong and W. U. Gardner, *Proc. Soc. Exp. Biol. and Med.*, 45: 287, 1940.

[8] L. W. Law and M. Lewisohn, *Proc. Soc. Exp. Biol. and Med.*, 43: 143, 1940.

[9] J. Furth, *Am. Jour. Roentg.*, 32: 377, 1934.

[10] P. S. Hinshaw, *Jour. Nat. Cancer Inst.*, 4: 513, 1944.

[11] W. U. Gardner, A. Kirschbaum and L. C. Strong, *Arch. Path.*, 29: 1, 1940.

[12] W. U. Gardner, T. F. Dougherty and W. L. Williams, *Cancer Research*, 4: 73, 1944.

[13] E. C. MacDowell, J. S. Potter, C. J. Lynch and A. Claude, Carnegie Inst. of Wash. Yearbook, 1937–38, p. 50.

[14] A. Kirschbaum and L. C. Strong, *Cancer Research*, 2: 841, 1942.

[15] J. Furth and M. C. Boon, SCIENCE, 98: 138, 1943.

[16] H. S. Kaplan and A. Kirschbaum, *Proc. Soc. Exp. Biol. and Med.*, 55: 262, 1944.

and sublines 12 and 212 of strain dba) were observed as untreated controls, and during and following the administration of x-rays or methylcholanthrene. The methylcholanthrene was applied percutaneously twice weekly in a 0.5 per cent. solution in benzene; 720 to 880 r of x-rays were administered by fractional irradiation, 80 r daily on successive days. Young adult animals of both sexes (8 to 10 weeks of age) were used. The latent period of chemical induction of leukemia in susceptible mice averaged approximately 120 days; the latent period of x-ray induction was longer, with 120 days the shortest preleukemic period. Table 1 records the results.

TABLE 1

Mouse strain	Number of mice	Spontaneous leukemia	Methylcholanthrene induced leukemia	X-ray induced leukemia
F	421	233 (55 per cent.)		
F	122		43 (35 per cent.)*	
F	34			0†
A	80	3 (3.8 per cent.)		
A	55		0	
A	56			17 (30 per cent.)‡
dba–212 ...	14	5 (36 per cent.)		
dba–212 ...	17		11 (65 per cent.)§	
dba–212 ...	12			0†
dba–12	26	0		
dba–12	97		63 (65 per cent.)	
dba–12	12			0

* Leukemia appeared precociously; per cent. reduced because of death from induced skin tumors.
† Leukemias that appeared were not manifest precociously, but appeared at the expected time of occurrence for this strain.
‡ Thirty-one animals still living. All leukemias appeared before any spontaneous case for this strain.
§ Leukemias appeared earlier than any spontaneous case for this strain.

The F strain was high in spontaneously developed leukemia (55 per cent.), susceptible to acceleration of onset of leukemia with carcinogens (30 per cent. leukemia before 200 days of age in methylcholanthrene-treated animals as contrasted with 6 per cent. in controls), and resistant to acceleration of onset with x-rays.

Strain A was low in spontaneously developed leukemia, resistant to induction of the disease with methylcholanthrene, but has shown at least a 30 per cent. incidence following exposure to 880 r of x-rays given by fractional irradiation.

Subline 212 of strain dba was moderately susceptible to spontaneous leukemia and markedly susceptible to carcinogenic induction of the disease, but resistant to x-ray induction or acceleration. Subline 12 of the same strain proved to be resistant to spontaneous leukemia or induction with x-rays, but very susceptible to the leukemogenic action of methylcholanthrene.

The results demonstrate that susceptibility of inbred mice, strains F and dba, to either spontaneous leukemia or the carcinogenic induction of the disease did not imply susceptibility to an agent, x-rays, which was, however, leukemogenic for genetically unrelated, low leukemia, and carcinogen-resistant animals, strain A. The problem of leukemogenesis in mice is very complex—first, multiple agents can induce leukemia; second, mice of only certain genetic constitution are susceptible to only certain agents; third, genetic susceptibility to one agent, or to the spontaneous disease, can not necessarily be correlated with susceptibility to other leukemogenic agents.

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THE NEUTRALIZATION IN VITRO OF AVIAN PNEUMOENCEPHALITIS VIRUS BY NEWCASTLE DISEASE IMMUNE SERUM

AVIAN pneumoencephalitis is the name applied by Beach[1] to a disease of chicks in California from 2 to 10 weeks old, formerly called "a respiratory nervous disorder,"[2] and also to a respiratory disease of nearly or fully mature chickens which had been known in different localities as "chicken flu" and "9-day pneumonia." The former was first observed in 1940, while the latter has been prevalent since 1935. Despite the fact that the spread of the disease through a flock is very rapid, transmission by artificial means proved difficult and was not accomplished until late in 1941. The cause of pneumoencephalitis was then shown[1,3] to be a filterable virus which could be propagated in chicken embryos.

The average mortality in outbreaks of pneumoencephalitis has been small, but in some instances as many as 50 per cent. of the affected chickens have died. The disease is always of economic importance to the owners of infected flocks, however, because of the loss resulting from its temporarily depressant effect on growth or egg production. The gross lesions seen in affected chickens are mucous exudate in the trachea and, in some cases, cloudiness of the membranes which form the air sacs and mesentery. After continued propagation in embryos or rapid passage through a series of chickens, however, the

[1] J. R. Beach, *Proc. 46th Meet. U. S. Livestock Sanitary Assoc.*, 203, 1942.
[2] J. R. Beach, *Nulaid News*, 18: 13, 1940.
[3] D. E. Stover, *Amer. Jour. Vet. Res.*, 3: 207, 1942.

virus becomes so highly virulent that inoculation of chickens with minute doses of it causes death in 4 to 6 days, and hemorrhagic lesions, particularly of the proventriculus and small intestines, are present in a majority of those which succumb. An interesting, and as yet unexplained, phenomenon of the artificially induced disease is that the infected chickens do not have the respiratory symptoms which are predominant in the natural disease. This applies to chickens infected by inoculation with material from field cases as well as to those inoculated with cultured virus.

Because of the highly virulent nature of the cultured pneumoencephalitis virus, it seemed of interest to determine if it might be related to the viruses of Newcastle disease or fowl plague, two highly fatal diseases of chickens which were not present in the United States. Through the cooperation of the Bureau of Animal Industry of the U. S. Department of Agriculture, a small quantity of anti-serum for each virus was received from England in February, 1943, and was used for *in vitro* neutralization tests with pneumoencephalitis virus. In these tests, mixtures of equal parts of serum, undiluted or diluted with saline, and of embryo-cultured virus were prepared and used for the intramuscular inoculation of chickens, 61 days old, in doses of 0.1 cc.

Chickens were not infected by inoculation with 1,000 infective doses of pneumoencephalitis virus when it was mixed with an equal quantity of undiluted or 1:10 or 1:100 dilutions of Newcastle disease immune serum. The virus was not affected, however, by mixing it with the fowl plague immune serum. These results indicate that the virus of pneumoencephalitis is immunologically identical with the virus of Newcastle disease.

It is hoped that the further studies of avian pneumoencephalitis which are in progress may yield an explanation of marked difference between the characteristics of the natural and artificially induced disease.

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THE ISOLATION OF THE ST. LOUIS ENCEPHALITIS VIRUS FROM CHICKEN MITES (DERMANYSSUS GALLINAE) IN NATURE*

EPIDEMICS of St. Louis encephalitis have occurred in St. Louis and in St. Louis County in 1933 and 1937. Since the epidemic of 1937 sporadic cases of the disease have been identified[1, 2] in St. Louis County. Although few in number the occurrence of these sporadic cases indicates that an endemic focus exists. The St. Louis area seemed to offer the opportunity for investigating the problem of inapparent viral infection in a community during a non-epidemic period. Therefore, a survey for the presence of type specific antibody to the St. Louis encephalitis virus in the human and animal population of the St. Louis area was undertaken by one of us to determine to what extent the population is being immunized to the virus of St. Louis encephalitis. In this study the data[3] obtained up to this time indicate that few individuals who have come into St. Louis County since 1937 show specific antibody to the St. Louis virus. On the other hand, a significant number of chickens, approximately one year of age, has shown a low titer of neutralizing antibody for the virus.

The work of Hammon *et al.*[4] has shown the natural occurrence of the St. Louis encephalitis virus in the mosquito *Culex tarsalis Coquillet* during epidemic periods. The experimental transmission of the St. Louis virus in chickens and pigeons by 9 species of mosquitoes from 3 genera has been reported.[5] These findings, together with other epidemiological studies by Hammon and his colleagues,[6] appear to indicate beyond reasonable doubt that the mosquito is a vector concerned in human epidemics of St. Louis encephalitis. However, the demonstration of neutralizing antibody in a significant number of one-year-old chickens in certain flocks in an area where the human population does not appear to be developing antibody suggested the possibility that some blood-sucking vector which does not bite man was transmitting the disease to fowl.

The common chicken mite, *Dermanyssus gallinae*, frequently infests fowl in this area. The chicken mite belongs to the same order of Arachnida as does the tick and the life cycles of the two are comparable in so far as the mite requires a blood meal before the moulting of the nymphs and before the oviposition by the adult females.[7] Therefore, the chicken mite seemed a possible vector in light of the experiments which have shown that ticks, under experimental conditions, are capable of becoming infected with two neurotropic viruses, the *Dermacentor andersoni* with the western equine encephalomyelitis virus[8] and the *Dermacentor variabilis* with the St.

* From the Department of Pathology and the Department of Pediatrics, Washington University School of Medicine. Aided by a grant from the National Foundation for Infantile Paralysis, Inc.

[1] R. J. Blattner and J. V. Cooke, *Jour. Inf. Dis.*, 70: 226, 1942.

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Louis encephalitis virus.[9] Furthermore, in both instances the ticks are capable of transmitting the infectious agents to susceptible animals by bite and of the hereditary transmision of the virus to their offspring.

Mites (*Dermanyssus gallinae*) were collected from a coop in which there were chickens whose sera had been shown to have neutralizing antibody for the St. Louis encephalitis virus. Of 6 chickens, 2 were definitely positive and 2 questionably so. The mites were kept in test-tubes for 7 days without feeding. At the end of that time 60 mites were triturated in tryptose broth in an agate mortar and .1 cc of the supernatant fluid was inoculated intraperitoneally into each of 6 nineteen-day-old Swiss mice. Young mice were used because they are more readily infected than adults by the intraperitoneal inoculation of the St. Louis encephalitis virus.[10] In 8 days 2 of the 6 mice showed signs of illness with slight twitching. When moribund these 2 mice were killed. Necropsy showed no gross pathological lesions and bacteriological cultures of the brains, spleens and lungs were sterile. The brains were emulsified and diluted 1:10 with tryptose broth. After centrifugation .03 cc of the supernatant fluid was inoculated intracerebrally into each of 8 mice and also on the chorio-allantoic membrane of the developing chick egg. Three days later all 8 mice appeared sick and developed convulsions. Five of these died before the close of the third day. The 3 others were killed when moribund. The latter 3 brains were emulsified and diluted 1:10 with broth. After centrifugation the supernatant fluid was inoculated intracerebrally in .03 cc amounts into 6 mice. On the third day these mice developed convulsions.

The egg membranes inoculated with the brain material of the 19-day-old mice appeared slightly thick and opaque when examined 3 days following inoculation. The embryos were alive and the allantoic fluid clear. The ground-up membranes were passed to mice by intracerebral inoculation and the mice developed convulsions on the third day following inoculation. All the mouse brains and the egg membranes have been bacteriologically sterile. The infective agent appears to have been established in mice and in the chick egg.

Filtration experiments with the infectious agent in a broth medium have shown that it passes readily through a Berkefeld N Filter.

Microscopic sections of one of the mouse brains from the second intracerebral passage show an encephalitic process which is apparently indistinguishable from the pathological picture of St. Louis encephalitis in the mouse.

TABLE 1

MOUSE PROTECTION TEST—A COMPARISON OF THE NEUTRALIZATION OF THE ST. LOUIS ENCEPHALITIS VIRUS AND OF THE VIRUS ISOLATED FROM MITES WITH ST. LOUIS ENCEPHALITIS IMMUNE SERUM

Dilution of virus mixture added to equal part of serum	Serum: Rabbit immune St. Louis serum — St. Louis virus	Rabbit immune St. Louis serum — Virus from mites	Rabbit Normal Serum — St. Louis virus	Rabbit Normal Serum — Virus from mites
10^{-1}	.....	6* 7 8 8	.....	.....
10^{-2}	9 10 8† 8	9 9 8 8	.....	4 4 4 4
10^{-3}	10 8 8 8	8 8 8 8	.....	4 4 4 4
10^{-4}	8 8 8 8	8 8 8 8	.....	5 5 5 5
10^{-5}	7‡ 8 8 8	.....	4 5 6 6	5 6 6 8
10^{-6}	8 8 8 8	.....	5 5 5 6	9 8 8 8
10^{-7}	.....	.....	6 8 8 8	8 8 8 8
10^{-8}	.....	.....	7 8 8 8	.....

* Numbers = day of death of 1 mouse.
† S = survival of 1 mouse.
‡ = death from unknown cause.

Identification of the newly isolated virus was attempted after 2 serial mouse brain passages. The brains of mice infected with the newly isolated virus are infective to a dilution of 10^{-6}, as compared with 10^{-8} for brains of mice infected with the strain of St. Louis encephalitis (Hubbard strain) used in this laboratory. With two different lots of serum of rabbits immunized to a known strain of the virus of St. Louis encephalitis, the newly isolated virus is neutralized to approximately the same extent as is the known strain of St. Louis encephalitis virus (Hubbard strain), Table 1. It is not neutralized by serum of a guinea pig immunized to the western strain of virus of equine encephalomyelitis.

A second isolation of the virus was attempted with mites from the original collection after they had been kept in test-tubes without feeding for four weeks. Thirty mites, predominantly nymphs, were triturated in broth as in the first isolation of the virus. The supernatant fluid was inoculated in .1 cc amounts intraperitoneally into each of 3 Swiss mice, 11 days of age. On the ninth day following inoculation 2 mice developed convulsions. Each of the 2 brains was passed to 6 adult Swiss mice by intracerebral injection. The inoculum was bacteriologically sterile. Two and a half to three days following inoculation these mice developed convulsions.

Conclusion: The St. Louis encephalitis virus has been isolated from chicken mites (*Dermanyssus gallinae*) in nature in the St. Louis area during a non-epidemic period.

MARGARET G. SMITH
RUSSELL J. BLATTNER
FLORENCE M. HEYS

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN EASILY CONSTRUCTED HEPP OSMOMETER

INTEREST in the use of gelatin as a blood substitute has emphasized the need for a rapid method for measuring colloidal osmotic pressures (C.O.P.). Hepp[1] has described a method in which the volume of fluid in the so-called outer chamber is exceedingly small, thereby insuring a relatively rapid attainment of equilibrium. The following is a description of a simplified form of this osmometer that is relatively easy to construct.

Fig. 1 represents a cross-section of the osmometer.

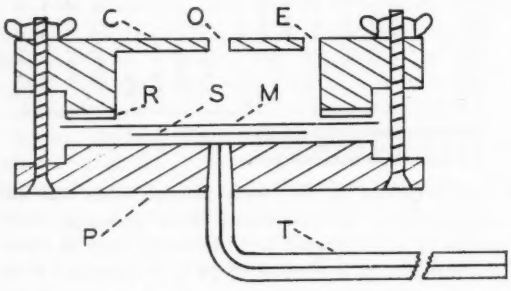

FIG. 1. A diagram of the osmometer showing relative positions of the membrane and silk cloth.

P is a circular platform made of lucite with an opening in the center into which a glass tube (T) can be inserted after warming the lucite in water. The end of tube (T) should be flush with the surface of the lucite. It is not necessary to taper that part of tube (T) that fits into platform (P). Leaks can be prevented by liberal application of DeKhotinsky cement to the base of this junction. The top part of the osmometer (C) is also made of lucite. The over-all diameter of the lucite pieces is 8 cm. The inside diameter of C is 4 cm and the width of the part of C in contact with the rubber gasket (R) is 1 cm. The diameter of the lumen of the glass tube (T) is 1 mm. A layer of ultrafiltrate or other appropriate fluid is placed on P, and a piece of silk cloth (S) and a membrane (M) previously soaked in the fluid are placed on top. Care must be taken to exclude air bubbles from under the membrane. The two pieces of lucite are fastened together by means of eight screws. The screws are threaded into P and act as guides in bringing C into contact with P. This procedure prevents the formation of wrinkles in the membrane. The rubber gasket (R) is necessary to prevent leaks between the lucite and the membrane. The experimental solution is placed in the chamber through opening (O). The fluid beneath the membrane is continuous with fluid in tube (T). The osmometer is placed on an appropriate platform in a constant temperature box (variation of air temperature $\pm$ 0.5° C.) with the tube (T) protruding to the outside through an opening in the box. Pressure (usually negative) is applied by means of a manometer (with large reservoirs to prevent uncontrolled changes in pressure) to tube (T), and the movement of the meniscus in tube (T) is observed with a microscope equipped with an ocular micrometer. A magnification of 80× is satisfactory. The pressure is adjusted until the meniscus moves slowly in a given direction and its rate of movement is determined. The pressure is changed (by about 20 mm of H_2O) so that the meniscus moves in the opposite direction, and its rate is again determined. The equilibrium pressure is calculated by interpolation. Equilibrium pressure is determined at intervals until a constant value is reached (usually within 10 to 15 minutes with plasma or serum, but not until 2 to 3 hours with gelatin). The C.O.P. is the sum of the interpolated pressure and the hydrostatic and capillary pressures of the fluids in the manometer (determined by the usual methods). With this method a number of osmometers may be used with only one microscope and one manometer, the tubes (T) being clamped off in between readings. The osmometer can be emptied through opening (E). The openings (O and E) are partially covered during a determination to prevent evaporation. For further details the articles of Hepp[1] and Peters and Saslow[2] should be consulted.

Cellophane (300 gauge) and collodion membranes have been used in measuring the C.O.P. of gelatin solutions.[3] In the writer's experience the Cellophane membranes show less variation in permeability (determining rate of passage of saline through the membrane under a given hydrostatic pressure) than do collodion membranes prepared under carefully controlled environmental conditions. However, a completely satisfactory membrane for the measurement of the C.O.P. of gelatin has not been found.

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SCHEINFELD, AMRAM. *Women and Men.* Illustrated. Pp. xx + 453. Harcourt, Brace and Company. $3.50. 1944.

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SCIENCE NEWS

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A SCHOOL OF PAN AMERICAN AGRICULTURE

At Zamorano, Honduras, a school of Pan American agriculture was formally opened on October 12, to provide technical education in American tropical agriculture particularly for students from Mexico, Central America and the West Indies. Its faculty includes scientists and educators from Middle America and from the United States.

Escuela Agricola Panamericana is the official name of the new institution. It will be conducted as a practical work-while-learning laboratory, furnishing free and expert technical training to a permanent enrollment of at least 160 young men carefully selected from Middle America.

When their training is completed students are expected to apply their technical knowledge and experience to the problems of their home lands.

The opening of this school is an event of more than local interest. As a result of the war Middle America is now supplying the United States with products formerly obtained in the Far East, and will probably continue to do so in the future because of the great agricultural developments that have already taken place. The Western Hemisphere may become agriculturally self-sufficient. To promote this self-sufficiency is one of the objectives of the new institution.

The Escuela Agricola Panamericana was founded and endowed by the United Fruit Company, but will be divorced from the personnel requirements of any particular company or commercial employer. It will function under a board of regents, five of whom are Central Americans. Its establishment and location were authorized by the National Congress of Honduras.

ITEMS

Amateurs interested in rediscovering Comet Berry, discovered at Dunedin, New Zealand, the middle of September, should search in the constellations of Crater, the cup, Leo, the lion, and Sextans, the sextant, according to calculations made at Aberdeen, Md., by L. E. Cunningham. "The comet is likely to appear as a faint, fuzzy patch of light, and can be distinguished from the many nebulae in the region by its motion past the stars. When this motion has been definitely proved, the position should be reported to the Harvard College Observatory." Since its discovery on September 13 the comet has moved into the part of the sky near the sun and is lost in the twilight. A cablegram from the Carter Observatory, Wellington, New Zealand, sent in reply to a request from Mr. Cunningham, states that the comet was last observed on September 16. At the time of its discovery, it was of the fifth magnitude and so was faintly visible to the naked eye. Three days later, however, it had faded to the sixth or seventh magnitude, and required a small telescope to see it. Unless the comet is accidentally rediscovered after it emerges from the morning twilight, its orbit will remain unknown.

A new advance in the design of frequency modulation receivers reduces interference from undesired stations in the reception of FM radio programs, according to George L. Beers, of the Radio Corporation of America, the inventor. The FM receiving system represents a new approach to the problem of reducing noise and interference. Known technically as a "frequency-dividing locked-in ocillator FM receiving system," it consists of an oscillator which automatically adjusts its frequency to the frequency variation of the signal of the desired FM transmitter. "Frequency modulation," Mr. Beers pointed out, "is still in its infancy in terms of a nation-wide entertainment service. Until a large number of high-powered FM broadcasting stations are operating on a commercial basis, the major technical problems which are involved in the design of FM receivers will not be fully appreciated."

Gas turbine engines for aircraft, approaching as much as 10,000 horsepower, may be available within the next decade, according to G. W. Vaughan, president of the Wright Aeronautical Corporation. While the principles of gas turbines have been known for years, it was only recently that research has improved their efficiency to a point of practical use and only recently that advances in metallurgy have provided the metals to withstand the heat and power stresses of such engines. In the high-power range, the gas turbine has many advantages. It offers a large saving in weight and fuel consumption for long-range operation at high altitudes. On a giant transport plane of the future, the gas turbine engine may mean a saving of as much as 8,000 pounds over present types of engines, permitting about forty more passengers, or four extra tons of cargo, to be carried on each flight. The use of the gas turbine engine is therefore expected to make possible sharp reductions in passenger fares and cargo rates.

Natural gas has been found non-injurious to growing plants and cut flowers, in experiments by Professor Felix G. Gustafson, of the University of Michigan. In this it is radically different from manufactured gas, which has long been known to be harmful to plants growing in homes and greenhouses, as well as to certain kinds of cut flowers. Potted plants of tomato, coleus, sunflower, snapdragon, marigold and several other species, as well as cut flowers of tulip, carnation and stock, were placed under bell-jars. In some of the bell-jars from one to two per cent. of Texas natural gas, taken directly from the pipe line, was added to the atmosphere. Other jars were left with only ordinary air in them, as controls. Although the plants were exposed to the natural gas for several weeks, none of them developed detectable injury in the one per cent. gas atmosphere, and only two of the cut specimens of plants showed damage in the two per cent. concentration. As a further check, manufactured gas was added briefly to some of the bell-jars containing natural gas. The plants promptly showed signs of gas injury, but recovered when the manufactured gas was taken out and only natural gas remained.

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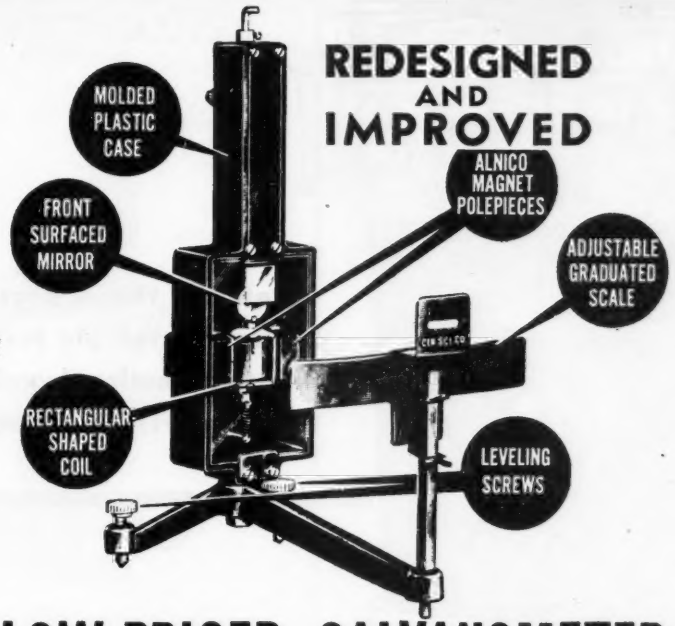

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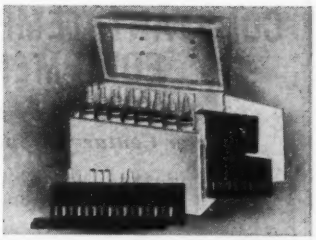

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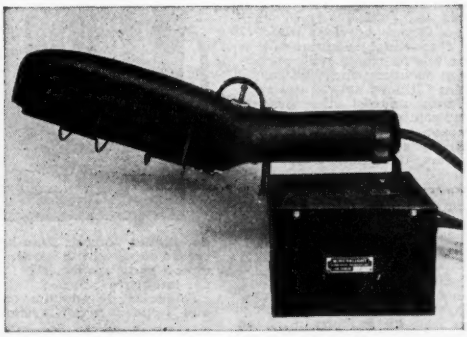

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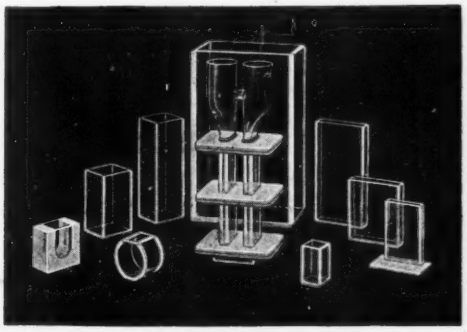

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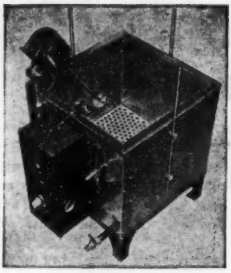

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For water or oil, with or without built-in refrigeration and/or shaking mechanism, for a wide range of operating temperatures which can be held as close as ± 0.02° C.

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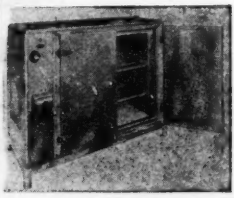

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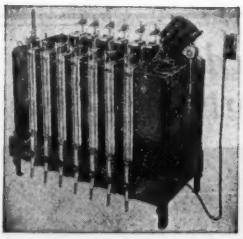

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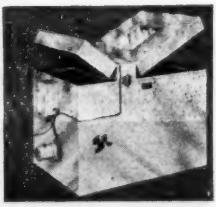

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4. Solution in water (1 g. plus 1 cc.): clear, colorless
5. Odor of solution: little or none at all
6. pH of the aqueous solution (5%): 4.6–5.7 (M.R.)
7. Loss in weight 3 hours 100°: max. 0.5%
8. Ash: max. 0.1%
9. Heavy metals: none
10. Nickel: none
11. Degree of Hydrolysis: max. 0.5%
12. Total Acetylcholine Chloride: min. 99.3%
13. Titration of the chlorine ion: 19.2–19.8% Cl. (calc. 19.53%)

M.P. of the dried substance 151° (corr.)
M.P. of the Picrate 110° (corr.)
N-content Calc. 7.7%

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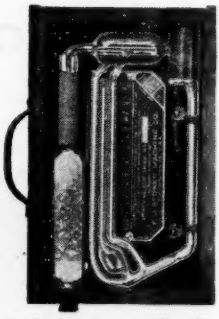

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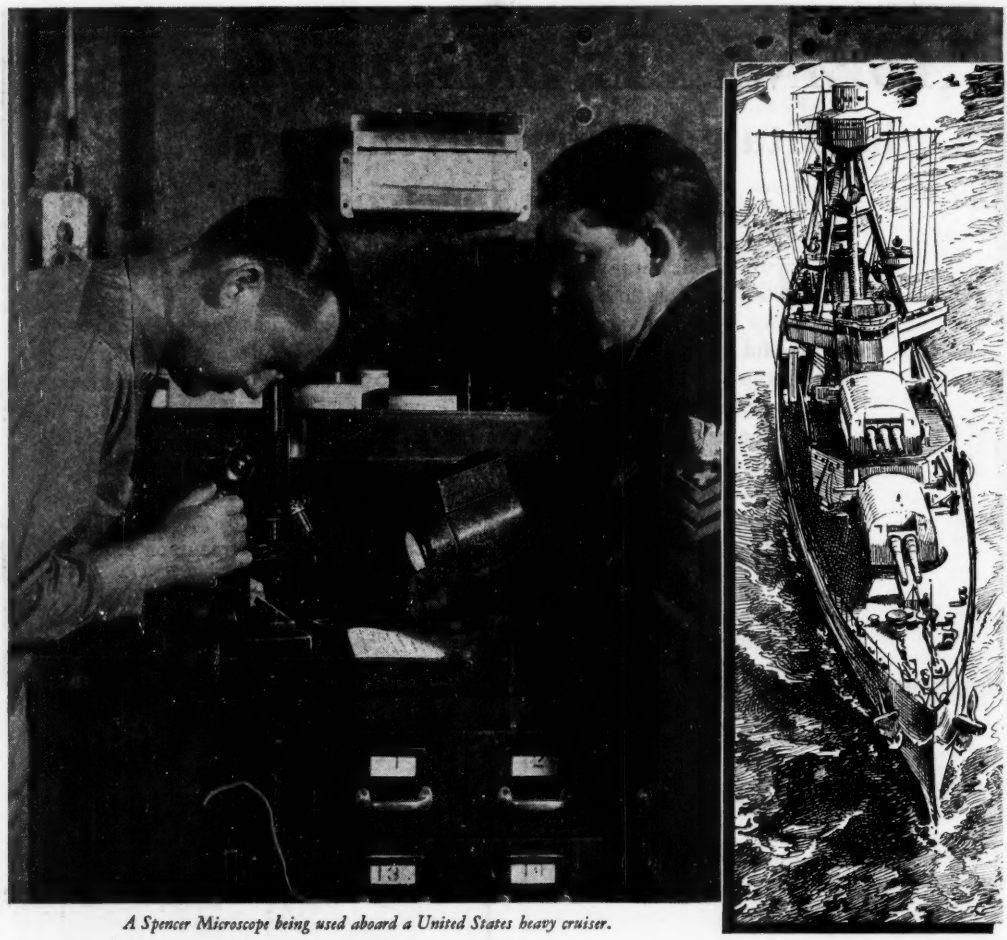

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